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SURVEYING IN CHICAGO.

(I.)

The construction and maintenance of the sewers, water-works, harbors, and public buildings, and the paving of streets in Chicago are under the control of the Board of Public Works, and the superintendence of the City Engineer, and a large staff of assistants. In times gone by there was *a* City Surveyor and a County Surveyor, the former enjoying the monopoly of the laying out of new subdivisions and such other surveying as came within the city limits; the latter enjoyed the same privileges in the county of Cook. But in 1863 a law was passed by the Illinois Legislature, which was further amended in 1867, whereby surveyors were licensed by the Board of Public Works to practice their profession in the City and County, their acts to be of equal force and validity with those of the County Surveyor. Under this act quite a number of *City Surveyors* are now practising in Chicago. The same law exists in St. Louis except that there the required bonds are much greater than in Chicago, being $15,000 instead of $2,500. In Illinois the County Surveyorship was practically done away with by the last Legislature, the law taking effect July 1st.

The system of licensed surveyors has worked well, as it opened a large field of work to competition, and the surveyors being responsible by reason of their bonds, and each one's surveys being constantly checked by those of other surveyors in the course of practice, had the tendency to make all very careful in their measurements. There are, therefore, comparatively few errors occurring, and suits on account thereof are exceedingly rare. The business of a city surveyor is to make surveys wherever wanted, to lay out subdivisions, locate lines for buildings, run levels, and give the grades of streets. There is no part of his work but what requires close attention, careful measurement, and the exercise of good judgment.

In laying out subdivisions and additions on the prairies beyond the city limits, years ago, the land was considered to be of little value and a great deal of careless surveying was done, which now, when the city has extended its borders, and the lands in question become occupied, creates perplexity among the surveyors, and occasional litigation among owners. A great many of the first surveys in the city were made from a standard which was a fraction in fifty feet too long, and the consequence is, that the correct measurements on these lines largely overrun and necessitate the measurement of a whole block and sometimes of the boundaries of an entire subdivision, or the length of a quarter section to enable the surveyor to locate a single twenty five feet lot.

The city authorities, moreover, have always been so far apathetic as regards correct surveys, in that they have neve restablished any permanent corners or monuments from which to make measurements or run lines, but on the contrary have always allowed street contractors and sewer builders to throw out what evidences of the location of certain corners there were in past years, without any note thereof being preserved, and in the entire city of Chicago to-day, there is not one corner established by the City from which to start a survey. Street lines depend largely upon the judgment of the surveyor, and owing to the numerous projections consequent upon the ornate street architecture of new Chicago, they do not always correspond. The original town was surveyed with a common compass, and the street lines although never varying much from straight lines, yet follow all the deviations of the ever varying magnetic needle, and must be run out each block by itself, while in other parts of the city the lines must be run between the extremes of the subdivision.

In the location of lot lines, where land ranges all the way from $100 to $4000 per front foot, and the masons are waiting for corners, the city surveyor realizes the necessity for right judgment and careful measurements and figures, as the leaning of a pin or the "kinking" of a chain may cause considerable mischief. In the location of lots also, the surveyor meets with quite a large class of difficulties. He sometimes finds that he cannot fit all the pieces of the subdivision; a part of the tract is built upon; old lines are claimed by possession and occasional old stakes are standing; supreme court decisions come in to perplex him, and the diversities in the practice of his fellow surveyors have to be reconciled.

Some surveyors lay great stress on the presence of original stakes from which to make their surveys, others have adopted the *pro rata* principle, and regardless of stakes or occupation, adhere to the records, while others adapt their practice to the evidence and necessities of each particular case; all are no doubt conscientious in the discharge of their duties, but considerable difference of judgment exists at times, which is either compromised, or rests in abeyance until at last the case finds its way into the courts for final decision.

WILLIAMSBURGH RESERVOIR DAM.—The recent investigation into the failure of this dam throw the blame upon Mr. Bassett, the contractor, who did not build according to the specifications. The report further states that its foundations were defective, and repairs were necessary immediately after its erection, and before it could be accepted by the commissioners. These repairs failed, as we reason by the result, in reaching the real fault in the Dam, and the carelessness of the Commissioners who approved the work after these repairs had been made and so ineffectually, should be taken more notice of than it has been and they should share the condemnation of the contractor.

In early Buddhist architecture, the square, circle, pyramid, crescent and triangle were the forms selected for its basis; the square symbolizing the earth; the circle, water; the pyramid, air; the triangle, fire; and the crescent, the winds.

FOUNDATIONS.

(III.)

Potts' Pneumatic Cylinders were first applied to a bridge on the Chester and Holyhead Railway, in which the tubes were sunk by means of a double air pump, the pile sinking as the exhausting process was continued; 19 tubes, each 12 inches in diameter, were thus put down, so that their heads were level, and to them a cast-iron plate was fixed, on which the pier was built. Experience has shown it to be advisable to make the tubes of larger diameter, so that now they are used 5 feet, and even seven feet in diameter, and upwards. In this case the simple exhausting process is not sufficient by itself to overcome the friction of the sides; another vessel has therefore been introduced between the tube and the air pump, and this is first exhausted, and then a communication is opened between the tube and the exhausted vessel, when a double effect is produced; the excavating or exhaust ing process as in the former instance, with the addition of a sudden blow on the head of the piles. It was a modification of this process that was adopted at the Rochester bridge, where the cylinders were used as diving-bells; a *plenum* being established in them so as to exclude the water, allowing the excavation to proceed within by manual labor; this is found to be preferable, as the cylinders will not descend in a stony bottom.

It occasionally happens that a good solid stratum is overlaid to some depth by ground of an inferior character; in this case it will be necessary to bring up a number of supports to carry the structure, unless the expense of bringing up a solid foundation of masonry would not be too great. The system of driving piles into the soft ground, withdrawing them and filling up the space previously occupied by the piles with sand or concrete, is a very desirable expedient in preference to using timber resting on the solid substratum.

The system of construction carried out in the foundation of the centre pier of the Saltash bridge, by Mr. Brunel, was by the use of a gigantic and novel application of the coffer-dam principle. The nature of the ground being ascertained, by boring at short intervals around the position of the intended foundation, a rough idea of the formation of the lower rock was arrived at. This rock was situated about 90 feet below the level of the water, being overlaid to the depth of about 25 feet, by loose sand and mud. The use of an ordinary coffer dam, under the circumstances, would have been impossible, but Mr. Brunel overcame all difficulties by constructing of good boiler-iron, a large wrought-iron cylinder, 35 feet diameter, 100 feet in height, and weighing some 300 tons. The lower portion of the cylinder, around its edge, was divided into eleven separate cells about 9 feet long by 5 feet wide. These cells at a height of about 20 to 25 feet above the bottom of the cylinder were covered by a wrought-iron dome—except at the extreme summit, where another cylinder 10 feet in diameter entered, extending a little way into the central space inside the cells. This apparatus was then lowered into the water exactly over the site of the intended foundation; each of the cells acting as a separate and complete diving-bell. When the mud was reached, workmen descended the central shaft, and by means of a connecting passage provided with suitable cut-off doors, reached the interior of No. 1 cell, and from thence, by means of small holes in the partitions, to all the other cells round the lower parts of the cylinder. The loose mud was dug out and carried first to No. 1 cell, and from thence carried up through the centre shaft, the large cylinder of course sinking as the mud and sand were removed. This was continued until the rock was reached. Labor was now directed in the same way until a level bed was cut some feet below the surface of the rock, on which, at length the cylinder rested secure. Masonry was now built inside the cells, and the water, mud, &c., was worked out of the main body of the cylinder. Masonry was stepped into the irregular rock in the centre, and from thence built up to above high water mark, the partitions of the cells, the wrought-iron dome, and the centre shaft, being all knocked away as the work progressed; thus, at last, leaving a huge column of masonry enveloped in an iron cylinder, resting securely upon and firmly bonded to the solid rock, 60 feet below the level of the water.

Timber grillage and pile foundations are the next resort; grillage has been used in many places, but has failed to prevent settling or secure uniformity of the same. The following are among the number of places where it has failed: Fort Pike and Fort Wood, La., Fort Jackson, Bienvenue Battery, S. W. Pass Lighthouse, St. Charles Hotel and first Presbyterian Church, New Orleans, Light House at Pass a l'Outre, and Custom House, New Orleans; in all the above, excessive and irregular settlement has taken place. The Custom House, New Orleans, La.. is founded upon a flooring of plank laid on the excavation, 7 feet below the street pavement. On this floor a timber grillage is laid of ½″ logs, "side and side," over which similar logs are placed transversely, distant from each other 2 to 3 ft. in the clear. The space between the timbers is filled with concrete, which is continued over the whole grillage for a depth of one foot. Counter arches of 1½ bricks thick supports the walls of the interior subdivisions of the building, thus throwing the weight of the building upon the entire surface included within the outline of the building. As a concrete and grillage foundation to support this heavy building, no greater surface to resist the weight and pressure of the walls could be attained. It is situated upon the firmest, driest, and most reliable ground in and about the city of New Orleans. The maximum settlement of the building in any one point, up to 1860, was 2′ 9″. This compressibility of the soil beneath the grillage was very variable. With all the foregoing examples it is about time grillage should be abandoned, yet it is not. In the 4th Ward of Milwaukee, a new and costly church was erected during the last year; the ground was a treacherous marsh, and an expensive and substantial grillage was used for a foundation. The result is that the tower has settled about 16″ and the adjacent portions about 8″, and the motion is still (1870) in progress, the building is cracked in many places, and may perhaps, be a total ruin in a few years.

With regard to pile foundations it may perhaps be as well to state, judging from the successful application of the same, that where they fail to secure stability the site should be abandoned; as experience has proven the failure of the grillage system, it has also taught the engineer the manner of solidifying com-

pressible soils by wedging the soil upon itself by means of wooden piles. Where a firm soil can be reached at a convenient depth, it is necessary to drive the number according to rules and formula deduced from experiments, to carry the required weight, but when this is not the case, then it is necessary to resort to wedging by driving a series of piles to the greatest practical depth, in rows of 3½ to 4 feet from centres, and to a depth of from 40 to 50 feet. If, after driving this series there remains any doubt of the stability of the soil, a second series of the same dimensions should be driven by placing one centrally between each four of the first series; it has been concluded by good authorities that if more than this second series can be driven the site should be abandoned as being too nearly semi-fluid for the construction of expensive structures. Generally the soil is sufficiently solid after driving the second series; they require then to be firmly united to prevent lateral motion, by securing them at different heights, that is by cutting the first low down and laying a tier of timbers across the same, and allowing the second to stand above to be secured by a second tier of timbers laid the reverse way, and crossing the first. The successful examples of this class of foundations are numerous; the City of Amsterdam, Waterloo Bridge, New London Bridge, Dry Dock at Brooklyn Navy Yard, Dock at Philadelphia Navy Yard, Dock at Pensacola Navy Yard, a portion of Fort Wadsworth, N. Y. Harbor, Fort Delaware, Delaware River; this number should be quite sufficient to recommend pile foundations in compressible soils. The City of Amsterdam, in the simple circumstances of its existence, is one of the most striking monuments of human industry and power which the world affords, built as it is in the midst of a salt marsh. In consequence of this the foundations of all the houses and public buildings are formed by driving piles of from 50 to 60 feet in length through the swampy ground, until they rest firmly on a solid bank of sand below the morass. The upper end of the piles are then sawn off to a level and covered with a thick plank, on which the masonry is constructed. This renders the foundations by far the most expensive part of an ordinary building. Structures of this description are not nearly so precarious as the inexperienced might imagine. Some buildings have declined very much from the perpendicular, but are considered quite as secure from falling as before; they are not thought equally secure from sinking in case the sand, on which the piles rest, should give way. An event of this kind happened in 1822, when a stack of warehouses, heavily laden with corn, sunk, and totally disappeared. This mode of foundations gave occasion to the witticism of Erasmus, who said that in his country great multitudes of people lived upon the tops of trees. The largest and most stately edifice, not only in Amsterdam but in the Kingdom of Holland, is the Stadt-haus, or Town Hall, which is supported upon 13,965 piles; the building is 282 feet in length, 255 feet in depth, and 119 feet high, exclusive of a cupola 41 feet high,. It is constructed of a material which is not to be found in the country; with the exception of the ground floor, which is of brick, it is built of freestone. The steeple of the Onde Kirk is 240 feet high; the surface or level of the natural ground is below the level of the ocean.

The Dry Dock, at the Brooklyn Navy Yard, N. Y., was commenced in 1841, and completed in 1851; it contains 13,837 cubic yards of masonry, resting upon 38,532 cubic feet of pile timber. The soil was found to be chiefly vegetable decomposition to the depth of 10 feet, and below this, almost impalpable quicksand, containing a large proportion of mica; when confined, and not mixed with water, it is very firm and unyielding, presenting a strong resistance to penetration; when saturated with water it becomes a semi-fluid, and moved by the slightest current of water passing through or over it. Small veins of coarse sand were also occasionally encountered, through which flowed springs of fresh water. Borings were made to the depth of 80 feet, and brought up sand, clay, and fresh water; there is but a small proportion of clay in any part of the foundation; the borings extended 40 feet below the foundation of the dock. The foundations for the superstructure of this dry dock were placed 47 feet below mean tide, and 42 feet below the surface of the ground. Black mica overlaid the quicksand under the coffer-dam. Under and in this coffer-dam 3,504 piles were driven, averaging 39 feet in length by 15 inches square. The earth above low water was removed before the coffer-dam was formed, and about 10 feet in depth was removed by dredging. The semi-fluid state in which the fluid was found, after the water had been pumped out of the pit, made it very difficult to remove; it was so fluid as to require tubs for its removal. Bottom springs of fresh water were found within about 6 feet of the required depth of the foundations; the largest discharged about 10 gallons per minute. When flowing from a level of 16 feet below low water it discharged 38 gallons per minute, containing 27 ounces of sand; at a level of 22 feet it discharged 33 gallons per minute; at a level of 17 feet it discharged 10 gallons per minute, unmixed with sand. These springs presented great difficulties in laying the foundations, from the flowing of the water, which, as it came up, brought large quantities of sand, which, in continuing to flow, would soon have endangered the surrounding works. The pressure of the water was so great as to raise the foundation however heavily it could be loaded. The setting of the piles supporting the pump well, was the first evidence of undermining from one of these springs; the site of the well was changed, but the spring followed, and compelled another change of the well. This spring was driven out of the old well by driving piles until it was filled up, but it immediately burst up among the foundation piles of the dock near by. In a single day it made a cavity in which a pole was run down 20 feet below the foundation timber; 150 cubic feet of stone were thrown into this hole, which settled 10 feet during the night, and 50 cubic feet more were thrown in, on the following day, which drove the spring to another place where it undermined and burst up through a bed of concrete 2 feet thick. This new cavity was repeatedly filled with concrete, leaving a tube for the water to flow through; but in a few days it burst up through a heavy body of concrete, in a place 14 feet distant, where it soon undermined the concrete, and even the foundation piles, which settled from 1 to 8 inches, although 33 feet long, and driven by a hammer of 2,200 lbs., falling 35 feet at the last blow, with an average of 76 blows to each pile, the last blow not moving the pile one-half an inch. It was then determined to drive as many additional piles into the space

by means of followers to force those already driven as deep as possible. The old concrete was then removed to a depth of 20 inches below the top of the piles. An area of about 1,000 square feet around the spring was then planked, upon which a floor of brick was laid in dry concrete, and on that another layer of brick set in mortar. The space was next filled with concrete, and the foundations completed over all, several vent holes being left between the floor and foundations. After a few days, when the concrete had well set, the spring was forced up to a level of about 10 feet above the former outlet, at which it flowed clean without sand.

Two other of these springs were closed by freezing, in 1848, and forced up in one case 800, and in the other 1,200 square feet of the foundation. This took place between the lower timbers and the planking, lifting also the first course of the stone floor which was from 12 to 15 inches thick. The whole number of bearing piles in the foundation is 6,549: they are chiefly round spruce timber, 25 to 40 feet long, averaging 14 inches diameter at the head; the average length of all the piles driven was 32′ 7″. The piles were originally driven 3 feet from centres, afterwards as many piles were driven as could be forced into the earth; wherever a hammer of 2,000 lbs. weight, falling 35 feet, drove the piles for the last few blows exceeding three inches per blow, another and a larger pile was driven alongside. With the exception of 541 all these piles were driven by hammers from 2,000 to 4,500 lbs. each, falling from 35 to 40 feet. The average number of blows, per pile, was 151 with the small hammers, and 50 blows only, per pile, with the large hammers; the 541 piles were driven with a Nasmyth steam pile engine.

[*To be continued.*]

*LEVEEING ON THE UPPER MISSISSIPPI.**

[CONCLUDED.]

The plan for the construction of the embankment was made after a careful examination of the material along the line of the work, to ascertain the angle of repose of the slope, when wet and dry. The recorded history of similar works in this and other countries was searched with care. We put ourselves in communication with experienced hydraulic and levee engineers, and also made a personal examination of the levees and levee districts in Mississippi, Arkansas, and Louisiana, and conversed with engineers and others in the South, who had gained extensive practical experience in constructing and maintaining levees.

The examination resulted in the adoption of the following general specifications, which have proved themselves eminently fitted for levee work in this locality.

The ground under the embankment to be cleared of all perishable matter, and the whole surface ploughed up in lines parallel to the centre-line of the levee, to give a bond between the original surface and the new bank. A ditch about three feet wide and as deep to be dug along the centre-line of the levee to cut off any communication there might be under the bank by means of decayed roots or logs. All trees within falling distance of the crown to be cut down. All stumps to be grubbed one foot deep for a distance of 15 feet, measured from the outside slope stake toward the centre-line, this precaution being taken to prevent any stumps protruding through the flat outside slope—a neglect to do this having caused several crevasses in the South. The stumps elsewhere under the levee to be cut close to the ground. The material for the bank to be earth, free from grass, weeds, roots, and all other perishable matter. Berms to be about fifteen feet wide outside and from ten to thirty feet wide inside. The material to be taken from the outside, and berm banks left across the borrow pits every one hundred and fifty feet to prevent a current along the berm of the levee. The cross section of the bank to be a crown at least five feet wide, an outside slope of three to one, and an inside slope of ten to one, the slopes and crown width to be varied according to material used and the height of the bank. Along the berm on the inside a seepage ditch is usually excavated, which extends to some slough or other low ground, where the water may have a channel to the Sny. The average height of the levee is about seven feet and a-half. The key-levee which crosses the Sny at the head of the district is twenty-eight feet high, twelve feet wide at the crown, with slopes of four to one and three to one, with the river slope protected from the current by brush work and willow fascines thatched upon the slope.

In the location of the levee line the highest ridges near the river were sought, but the cavings and makings of the river banks were carefully studied, and the principle on which they moved and the rate of progress noted with pains, that in no place the embankment might in many years be in danger of being undermined by the abrasion of the banks by the current. Straight lines were obtained as far as was practicable, and, where a rectiliniar alignment could not be had, as easy curves were introduced as the ground would permit.

Having described the general characteristics of the district and the mode of constructing the levee, it may be asked: Does the district combine those requisites, which are essential to a successful reclamation of leveed lands?

We answer, that with a bank properly constructed of the material at hand, be it sand, loam, or clay, the lands will be reclaimed, if there is a sufficient natural interior drainage for the district.

This important fact is the secret of the success of the Southern levees, and the absence of this drianage in the numerous small pocket levees in the country has always resulted in disappointment to those constructing them.

As an illustration of the former, we have the great Yazoo district of the Mississippi, with its seven million acres, drained on one side by the Sunflower, on the other by the Yallabusha; receiving these as tributaries, the Yazoo, its head closed at the river, runs down the country parallel with the river for two hundred miles, and finally empties into it at Vicksburg. As an illustration of the latter, we have the levee at Cairo, and that in Clark Co., Missouri, both of which are failures, without some artificial means of getting rid of the seep water.

To illustrate the manner in which the drainage of the Sny levee district is performed, we will relate a few facts noted during the high water of last year; at this time, eighteen miles of levee was constructed.

Hitherto, during the high water, the district being threaded in every direction by the Sny and its tributary sloughs, the head of water, occasioned by the rising river, forced the water through the sand underlying the soil, and the whole district was quickly overflowed. This year the head of the mai stream that brought the river water into the district was closed, and the various cuts and low grounds along the river leading back into the country, were closed by the levee embankments, cutting off completely the overflow of the river. At the lower end of the eighteen miles of levee the river had an inlet into the back country, through a deep, wide, slough, called the "Great Cut-off." which we were unable to close before the high water. To ascertain the effect made by the levee, levels were taken simultaneously several times at three points on the Sny, one at the cut-offs, another opposite

* A paper read before the Civil Engineers' Club of the Northwest by E. L.Corthell, Chief Engineer of the Sny Island Levee

Hannibal, and the third under the key levee at the head of the Sny. When the river was nearly stationary, the height of the water, referred to the same datum plane, was the same within half an inch.

The key levee is sixteen and a-half miles above the "Great Cut-off," and the difference in level between the water outside and inside was eight and a-quarter feet. The Sny opposite Hannibal, was, by daily gauge readings, taken for a month, found to average six feet.

These facts proved conclusively, first, that our slope of the river was correct, and, secondly, that there was not sufficient seepage water passing from the river to the back country to make a fall in the Sny of even one-half inch in eighteen miles.

A phenomenon which astonished the people living on the banks of the Sny, who where ignorant of the results that would follow from the construction of the levee, was a perceptible flow in Sny from *south to north* during the time the river was rising.

A more practical and cheering phenomenon was the cultivation of the fields at the upper end of the district during the highest water, the ground being perfectly dry, while the river outside the levee was higher than the heads of those working behind it.

It is thus proved that the construction of the levee will accomplish the perfect reclamation of the whole district, after, perhaps, some interior drainage is done, to allow the Sny, with its net-work of drains, to carry the rainfall and seepage water readily to the river at the lower end of the district. When this interior drainage is perfected, the district is not only reclaimed from overflow, but is irrigated to such an extent by these natural water channels as to save it from drought, while surrounding country is suffering and the crops are dying.

No better evidence can be adduced to show the success of the work than the fact, that, already, the land reclaimed, and to be reclaimed, has increased in market value five hundred per cent., and that the people, unwilling before to improve their farm, only to see their improvements swept away every two or three years, and themselves and families driven by the rising waters to seek safety on the high grounds across the river, have already expended thousands of dollars in building substantial fences and houses, in ditching and draining the low grounds, and in preparing for a harvest this coming year unprecedented in this district.

Having benefited themselves by the construction of the levee, the question may be asked: Have they injured the people living on the other side of the river, by raising the water above its general level?

We think not. Above one-twentieth of the whole volume of water at extreme high water is thrown from the district into the river proper by the construction of the levee. The invariable result of placing obstructions in the river, as at the bridges in Quincy, Hannibal, and Louisiana, is a deepening of the bed rather than a raising of the surface of the water. The velocity is increased and the sand moves.

Our views as to the principles involved in the case can be stated in no more forcible language than in that of Colonel Forshey, at New Orleans. He says: "Levees confine and concentrate the waters, concentrate and increase the force, therefore increase the abrasion, therefore increase and enlarge the capacity of the channel."

In a river with a sandy bed, nothing is more certain than that having thrown more water into the river the result will be at once a deepening of the channel. To illustrate by facts, already noticed in regard to the levee: Comparative heights, taken at Quincy, Hannibal, and Louisiana, during the flood of last year, showed that at Hannibal, where the levee, if anywhere, would affect the river, there was no increased height appreciable, but a temporary increase of velocity and a resulting scour equal in area to that of the volume of water thrown into the river by the levee.

The subject of levees, new as it is to the Northwest, is one which is soon destined to be of vital importance to our people. In Illinois, alone, it is estimated that a million acres of her most fertile lands are devastated by the overflow of the rivers. Along the Mississippi, the Ohio, and the smaller rivers are numerous tracts waiting for the day of reclamation, and it devolves upon us, as civil engineers, interested in works of the greatest importance to the public, to address ourselves to the task and to become the pioneers in an enterprise fraught with so much substantial benefit to the country, and we can find in this conflict with the rivers much of that bold and daring work that is the delight of our profession.

We have before us the examples of the finest engineering talent of Italy, the cradle of our science. It was here, in the attempts of the best engineers to reclaim, by embankments, the rich tracts along the Po, Tiber, Arno, Reno, that the best principles of hydraulic engineering were evolved; and we can in no more illustrious way follow in their footsteps, than by rescuing from the rivers the richest portion of our heritage.

LOUISIANA, MO., Jan. 8th, 1874.

SO-CALLED PRACTICAL MEN.

One type of the practical man is of the "self-styled" variety, the most numerous, probably, existing. He is the least useful as an individual, the least progressive as a brain worker, and the least enlightened as a member of the human race, of any class of civilized mankind. He is a compendium of thumb rules, an epitome of set ideas encircled by the iron barriers of his own mind, which allow of neither the substitution nor admission of better views, nor the expansion of those within. At mere handicraft, he may be skilled; but ask him for a reason and he is dumb. He it is who leads the ban of the shriekers against free and liberal education, who clings to that sophism which argues that the "world is the best teacher;" who turns his son directly from the nursery into the shop; who renounces the inventor and all his works, until compelled by absolute force of circumstances, to yield to progress; and finally, who, having no knowledge other than his manual skill and set of thumb rules, scorns it in others.

"But we want no long-haired philosophers to run our shops," possibly thinks the reader. True, nor need we have them. "Science," says Lord Brougham, in his fine definition of the term," is knowledge reduced to system." The true scientist is he who not only possesses this systematic knowledge, but, if he be so situated as to require its immediate aid, knows how to put it in practice. He is neither the sage who meditates erudite abstractions, nor the *soi-disant* "practical man" who devotes himself to mere system. He is eminently the man of practice, but of intelligent practice, who is a master of principles, of reasons: to whom the mere application of a truth is nothing as compared with the truth itself; the latter immutable, the former an idea to be changed as occasion may require or judgment suggest. Such is the person we mean when we seek the "practical man," not the blatant individual who thrusts himself forward under that title.—*Scientific American.*

COMPRESSED AIR AS A MOTOR.

The use of compressed air as a motive power is destined to receive an enormous development as its capabilities and advantages become better understood. What countless wealth is thrown away in the unheeded fall of our rivers and the flow and the ebb of the ocean tides, simply because few consider that the power thus wasted could be conveyed to almost any distance, at very trifling cost, by means of compressed air, or rope transmission! As long ago as 1837, a series of experiments were made in Corsica, by order of the Italian government, to determine the resistance of tubes to the flow of air through them; it was found that:

1. The resistance is directly as the length of the tube.
2. It is directly as the square of the velocity of the flow.
3. It is inversely as the diameter of the tube,

And as the volume is directly as the square of the diameter when the velocity is given, it follows that, under a given pressure and velocity, the relative resistance, that is to say, the resistance divided by the power will vary inversely as the cube of the diameter.

There is, consequently, a great advantage in making the tubes and openings through which the air has to pass as large as possible. Experience has shown that tubes can be made so as to allow of very little leakage. At the Mont Cenis tunnel, no leak was ever found in tubes nearly a mile and a half in length, nor did the expansions and contractions of the tubes, due to changes of temperature, appear to affect sensibly the firmness of the joints. On one occasion it became necessary to leave the receivers of compressed air for 24 days; the loss in all that time did not exceed 5-1000 part of the daily supply.

It is therefore possible to transmit power by compressed air to very great distances, with scarcely appreciable loss in its transmission. There is, however, a much more important loss than that just mentioned When air, or any other elastic fluid, is compressed, there is generated an amount of heat which is the exact equivalent of the force employed in the compression. This heat, in practice, is radiated from the com pressor, the reservoir, and the tubes, and is lost; when the compressed air has obtained the temperature it possessed before compression, it has lost in cooling exactly as much power as was expended in compressing it; but since the air still remains under a considerable pressure, if allowed to expand, its temperature falls below that of the atmosphere, and in so doing it develops work; but inasmuch as the temperature in expansion will not be depressed nearly as much as it was increased in compression, the loss of work will always be considerable, increasing with the pressure to which the air has been subjected; the loss is moreover susceptible of exact calculation. Taking the case of the Mont Cenis tunnel, where a pressure of six atmospheres was attained, the air, instead of being compressed to one-sixth of its volume, as would have been the case where no heat generated, actually entered the reservoir when its volume had been reduced but 3-6 times, and, theoretically, the power available would have been but 60 per cent. of that expended; practically it was somewhat less than this. If the air were compressed to eight atmospheres, there would remain available but 55 per cent.; and for about eleven atmospheres of compression, but 50 per cent. of the compressing power could be obtained. If the compression is less, say four atmospheres, 67 per cent. would be secured; for three atmospheres, 73 per cent. would, according to theory, be available, and so forth; hence we see that where the lower pressure will perform the work to be done, and will not necessitate the use of extra large and costly engines to utilize the power, there is an evident advantage in not using a very high degree of compression.

To this loss of power, practically inherent in compressed air, we must add the loss due to its transmission through tubes; this, where the pressure is not excessive, and where the velocity is reduced by the use of large tubes, is a much smaller item of loss than the other: it would not be over one-third or one-fourth of it. In carrying the air through, say 10 to 15 miles of pipe, it would not exceed, say, 5 to 8 per cent.

As we have stated, it is impossible, under ordinary circumstances, to utilize more than, say, fifty to sixty per cent. of the power expended in compressing the air; yet, from the fact that compressed air enables us to carry, at a small cost, the power wasted in waterfalls to points where it can be used with advantage, the loss of fifty per cent in the motive power is a small matter, and the actual power obtained would cost in general much less than if generated with our most economical steam engines.

The use of compressed air for driving underground machinery, whether it be hoisting engines, rock drills, coal cutters, or other machines, is peculiarly advantageous, for it provides a valuable addition to the ventilation of the mine, and reduces the temperature, which in deep mines is so excessive. It can be carried to a much greater distance than steam, which, moreover, is very destructive to mine timber.—*Engineering and Mining Journal.*

THE SELECTION OF A BUILDING STONE.

This is a subject which has been under the pen of most writers on construction. Yet, notwithstanding this extensive treatment, no general principles have been indicated to direct the selection of a stone for an intended structure. To the engineer, in particular, the selection of materials suitable to the variety of works he executes, is a matter the importance of which is of itself evident. It is to elucidate the principles which should guide him in this portion of his labors that this article has been written.

A continued practice in one direction by reason of some prominent good quality which a stone may possess, often prejudices many builders in favor of the particular class to which it belongs. But an extensive experience in all countries leads to the conclusion that a perfect stone is one which has several good qualities, which is strong, durable, capable of being ornately worked, and of a fine appearance. For engineering works situated in the country, strength and durability are the only points which need be considered. Nevertheless, it is often difficult to obtain a stone which will fulfill even these two requirements. How a stone stands in regard to them, may be determined as accurately as the usual tests admit. No test for durability, however, has yet been discovered which may be implicity relied upon; as yet no known test relating to this point should be admitted by the engineer if he would remove from his shoulders all blame of future accidents. A thorough examination of a stone, comprising that of its quarry, of its structure, of its constituents, leads generally

to correct results. The plain character of engineering works in the open country, with their architectural effect depending only upon the proportion and disposition of their masses, does not require stones capable of being dressed as elaborately as those for city structures. For this reason this quality does not play here an important role.

As regards appearance it may be remarked, that the surroundings are usually in harmony with it, or whatever color and texture the stone may be. Therefore, even if circumstances did not compel the engineer to employ the most accessible stone, paying attention only to strength and durability, there would really be no necessity to consider anything else. On approaching a large town, however, regard must be had to all the foregoing qualities. The class of work now changes. Here are located shops, depots, and dwellings. These will be in contrast with other buildings, and show to advantage or not, according to the good or bad choice of their material. The architectural principles which here govern the engineer become more complicated and numerous, and demand in consequence, a fine stone. Nevertheless, all should not be sacrificed to architectural considerations. Financial matters demand reflection. It would not be wise to draw from distant sources such a stone, when a good one though inferior in structure and appearance, exists in the neighborhood. In such a case, the engineer must put up with what nature offers him, and employ a style of architecture which will be more in keeping with his material. But in cities a handsome depot demands a handsome stone. If no quarries in the vicinity furnish it, recourse must be had to others more remote. The expense may be considerable, but it must be borne in mind that an ugly material will make a building doubly so, specially if large and surrounded by better architecture. Should a fine stone not be offered, let brick then be used in preference to an inferior one. Some respect should be paid to the requirements of art.

In selecting a stone for an intended structure in a city, we must be governed in our choice particularly by a consideration of the class of ornaments which are to appear on the building, and by the expression which it is to possess. If the structure is to be decorated with plain large mouldings of a bold outline, then a coarse-grained and dark stone may be used. But should it, on the contrary, be embellished with delicate carvings, or with small figures in relief either on the mouldings or the plain wall, a light-colored and close-textured stone is required. No dark or cross-grained stone should be employed in this latter case. For a dark stone will fail to make the shade and shadows of these small ornaments perceptible, thus greatly diminishing their effect. A coarse-grained stone will not admit of fine edges being cut on it, and it is only by such luminous lines that we are enabled to clearly define the shape of the ornaments. For the want of either shade or luminous lines, small figures in relief will often, when viewed from no great distance, appear like lumps raised on the surface of the stone. This is particularly the case after the building has stood for a number of years. On a new building everything is clean. The stones are lighter than the permanent color they will finally assume under the influence of the air, dust, or smoke. But the most powerful agent of destruction is the humidity of our climate, under the attacks of which all stones succumb more or less. This is easily perceived on examining the edges. Such an examination will show that a coarse-grained stone exhibits more plainly the marks of the attacks than a fine-textured one. The particles are comparatively large, and those which are removed leave correspondingly large vacant spaces. Hence it is wrong to carve on such a stone, whatever may be its merits in other respects. Twenty winters will often be sufficient to destroy the edges of ornaments on a coarse-grained stone of great durability. Those effects are noticeable particularly when the stone is situated in a place exposed to the prevailing winds and rains, whether in the streets of a city or the open country.

The preceeding is a fundamental rule in architecture, yet it is constantly violated. When decoration in a high degree is intended, marble is the most appropriate stone for this class of work. The turn of a leaf carved out of this stone may be distinctly seen placed on the summit of a spire; for the material retains its sharpness of contour, its edges reflect the light, and its shades are visible and effective. In nothing more did that fine race, the Grecians, show their exquisite taste than in the choice they made of this material for their edifices.

Passing now to consider a stone with reference to the expression which its color may communicate to a building, it may be laid down as a general rule, that a light-colored stone is adapted to nearly all buildings, whether of a massive or light, a magnificent or plain, character. But structures intended to have a sombre appearance should be built of the darkest stone procurable. Nevertheless, if they are not well designed, the full effect of such a stone will not be brought out. This material may be used also in combination and contrast with lighter stones, producing quite a picturesque effeect. Grandeur of style, however, demands sameness of color. A medium dark stone gives an air of repose to a building built with it. Still, it should be used either in open situations or in those in which it may receive plenty of light. Hence a narrow street may be considered as an unfavorable situation for its employment.

The finest light-colored sandstones are doubtless those best suited for the purpose. A good limestone is also a fine stone in every respect. Some varieties of this stone preserve their color very well. For, being smooth, the dust does not much adhere to it. Many argillaceous stones, on account of their slaty structure, are disagreeable to work, yet they may be advantageously employed. A coarse-grained granite is open to the objections frequently urged against all coarse-grained stones, though some fine-grained varieties, obviating these inconveniences, make fine building stones for moderately decorated structures. But, in general, granites become quite dark with age; and for close views, as those obtained in a street, they are not, in the opinion of the writer, as effective in appearance as stone the constituents of which are all of an uniform color. For many of the plain works of the engineer, granite may properly be considered as the most desirable material. In basements, particularly in those of depots, it may be introduced on account of its not showing the grease as much as some other light-colored stones. Under the name of granite is here included also that stone known to writers on mineralogists as syenite, and which is especially referred to in the foregoing remarks.—*Jour. of the Franklin Inst.*

THE plans of the line which is to ascend Mount Vesuvius are now complete. The route will be 16.1 miles in length. The grades are 20 and 35 per hundred, and the road terminates a few feet from the crater. There will be one station, protected by a sort of break-lava, which will divert the flow, in case of eruption, away from the building and rails. The road is so laid out as to be naturally sheltered at every point, except for a distance of about 60 feet.

SIX steam boats are now plying on the Erie canal, and twelve others will shortly be added, all capable of making the trip from New York to Buffalo in five days. It is believed that the grain trade of the fall will be considerably affected by the increasing cheapness of transportation.

ENGINEER, ARCHITECT AND SURVEYOR.

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A few extra copies of the two page Illustration in our last number, "Examples of Sewers, and Faults in Building them," were lithographed, and can be had on application to this office, for 10 cents each, postpaid, or with the accompanying regular number of the Journal, for the sum of 20 cents each copy.

Articles intended for publication should be sent in by the tenth day of the month. Contributions solicited.

All communications relating to THE ENGINEER, ARCHITECT, AND SURVEYOR should be addressed to THE EDITORS,
168 Washington Street.

CHICAGO, ILL., AUG. 15, 1874.

CONTENTS.

Surveying in Chicago,	69	Our Note Book,	76
Foundations,	70	Windmills,	77
Leveeing on the Upper Mississippi,	72	Answers to Correspondents,	79
So-called Practical Men,	73	Electrical Researches,	80
Compressed Air as a Motor,	74	Steam Towage on Canals,	80
Selection of a Building Stone,	74	Law and Legislation,	81
Blast Furnace Slag,	76	Construction of Dams,	82

BLAST FURNACE SLAG.

The utilization of slag from furnaces has for some time occupied the attention of many practical chemists and metallurgists.

It has been broken up into small pieces and found to be an excellent material for macadamizing roads, and in some districts is extensively used for that purpose.

Slag ground fine and mixed with hydraulic cement, has also made a very durable and cheap artificial stone for building purposes.

The most extensive use, however, which will probably be made of it is in the form of a fertilizer. This is obtained by disintegrating the slag; the process being to let it run direct from the furnace into a large vessel filled with water, which granulates it, thus causing it to disintegrate the more rapidly when exposed to the action of the elements in the open air. The soil rapidly assimilates its ingredients, which are chiefly silica, lime, phosphorus, and iron, and is thus refreshed and re-invigorated.

Sugar cane and the various description of grain crops, especially wheat, require much silica to give strength to their stalks to withstand the storms. Both lime and phosphorus are of the greatest importance as ingredients of the majority of soils; in fact, "*phosphates*," is one of the three great divisions into which fertilizers are divided, viz: phosphates, nitrates, and silicates. Of the *nitrates* slag generally possesses none, or at most, very little, as almost all the nitrogen formed during the process of combustion in the blast furnace passes off among the waste gases.

The use of blast furnace slag then, as a fertilizer, is but little more than a question of expense of carriage, or "freight charges," as it can be procured at the furnace site for a very small sum, the expense of a granulating machine to the ironmaster being not large, thus enabling him to sell the granulated slag at a small sum, with an ample profit to himself, and a riddance of a waste material.

OUR NOTE BOOK.

Our cordial thanks are due to the City Surveyor of New Haven, for the City Year Book, recently sent us. We are sorry that our limited space does not admit of a review of the same in this number; in the next we hope to notice the many points of interest contained in the City Surveyor's Report, and those of the Boards of Streets and Sewers, &c. We take this opportunity, also, of requesting those of our readers who are City, Town, or Village Engineers and Surveyors, to do us the favor of sending copies of such Reports or Year Books as may be published by their respective towns. Their receipt will be cordially acknowledged, and their contents made use of for the general benefit of our readers, thereby disseminating throughout the United States, a knowledge of the general practice of City Engineering in its various cities and towns, which must eventually prove very beneficial to City Engineers themselves, in promoting self improvement and uniformity of practice throughout the Union.

The attention of our correspondents is called to the decisions 81 and 82, which appear in the columns of "Law and Legislation." The length of occupancy which gives valid title in different States is a matter of much interest, and we shall be happy to receive communications thereon from all parts of the country.

A correspondent draws our attention to the fact that the Rule on page 11 of our first number, for finding the weight of rails, gives the result in the *long* ton of 5,240 lbs.; for the ton of 2,000 lbs, he maintains that the rule should be: Multiply the weight per yard by 1.76.

ERRATUM.—As will probably have been noticed by our readers, the fraction in the formula, on page 61 of No. 4, line 4 from the top should read $\frac{2x}{3\times 2}$ *not* $\frac{2x}{3\times 2x}$

WINDMILLS.

On page 34 of our present volume we promised to give some further data concerning windmills, whereby those interested might be able to determine for themselves the general dimensions necessary for the construction of a windmill.

General formulœ for this purpose will be found in almost every text book on Civil Engineering, and in most of the mechanical pocket books; but as every mechanic should know the *reason* of the works he constructs, as is remarked in the article on "Practical Men," in this number we give in this article the principles which govern the construction of windmills, which are chiefly the results of many experiments by the far-famed Smeaton, and the illustrious hydraulic engineer and mathematician, Coulomb.

An example of former practice in the construction of windmills is then given, and compared with one of several modern mills which, we are glad to say, are being extensively erected in the Western States and Territories.

At first sight it appears that the greater the area of sail surface exposed, the greater will be the useful effect of the wind; and reasoning thus, a complete circle would appear to be the best form for windmill sails. Experiments have proved however, that the wind requires a certain space left open for it to escape after impinging upon the sails, this space amounting to ⅛ the area of the circle described by the sails of the windmill in motion.

If F=the force in pounds with which the wind strikes any surface perpendicular to its direction, A=the area of that surface in square feet, and V=the velocity of wind in feet per second, then the following formula will give this force; F=.002288 AV.

As the wind does not act perpendicularly on the sails of a windmill but at a certain angle, it is necessary to vary the degree of inclination of the sail at different distances from the centre of motion according to certain angles; this is called "weathering" the sail.

The angles referred to may be found by the following formula in which A=the required area of the sail with the plane of motion at any part of the sail, R=total radius of sail in feet, and D=distance from the axis of that part of the sail at which the angle A is required; then $A=23^{\circ}-\frac{18\,D^2}{R^2}$

The principles deduced from Smeaton's experiments are the following, the velocity of the wind being represented by V.

1. The velocity of windmill sails, whether unloaded or loaded, so as to produce a maximum, is nearly as V, their shape and motion being the same. 2. The load at the maximum is nearly, but somewhat less than, as V^2 the shape and position of the sails being the same. 3. The effects of the same sails at a maximum are nearly but somewhat less than, as V^3. 4. The load of the same sails at the maximum is nearly as the *squares* and their effects as the *cubes* of their number of turns in a given time. 5. When the sails are loaded so as to produce a maximum at a given velocity, and V increases the load continuing the same, then, when the increase of V is small, the effect will be nearly as the *squares* of the velocities; but when the velocity is double, the effects will be nearly as 10:27.5, and when the velocities compared are more than double of that where the given load produces a maximum, the effect increases only as the increase of V. 6. If sails are of a similar figure and position, the number of turns in a given time will be inversely as the radius of the length of the sail. 7. The load at a maximum that sails of a similar figure and position will overcome, at a given distance from the centre of motion will be as the cube of the radius. 8. The effect of sails of similar figure and position are as the square of the radius.

These principles and experiments have determined the following proportions for the various parts of the sails in the windmill with vertical arms (generally 4 in number), formerly constructed. Angle of axis of shaft of wind mill with the horizon in a level country,=8°; on high exposed positions it=15°.

Breadth of the whip (or arm)	at axis	=	1-30th	length of whip.	
Depth	"	"	"	= 1-40th	" "
Breadth	"	"	at tip	= 1-60th	" "
Depth	"	"	"	= 1-80th	" "
Width of sail			"	= ⅓rd	" "

This width of sail is divided by the whip in the proportion of 5 to 3, the narrow portion being nearest to the wind.

Width of the sail at axis=1-5th length of whip.
Distance of sail from axis=1-7th " "

Cross bars from 16 to 18 inches apart.

If HP=horse-power, A=total area of all the sails in square feet, and V=velocity of wind in feet per sec., then $HP=\frac{AV^3}{1080000}$; the velocity of the tips of sails=2.6V.

For the purpose of comparison we take an example of the windmill mostly employed in Flanders, principally near Lille. These mills have four whips each 40 feet long, and about 6.5 feet broad. The sail-covered portion commences at 6.5 feet from the axis of the mill and is 32 feet long. The total effect of these mills working an average of 8 hours per diem for the whole year, is 218000 foot lbs. per minute, or 6.6 horse power, or taking the total effect of e man's working for 8 hours per diem as 3600 foot lbs. per minute, it is equivalent to the work of about 61 men.

We now turn to the illustrations, which are those of a modern windmill constructed on the principle of Halladay's patent, at Batavia, Ill.

FIG. 1.

Fig. 1 represents a general view of the mill, and Fig. 2, the arrangements of the head and regulating apparatus to an enlarged scale. In Fig. 2, *A* is a casting bolted to the mast of the tower, and further supported by the two braces *E E*. Upon this sits the Turn-Table *B*, provided with rollers (not shown in cut) allowing it to turn freely as the wind changes its direction, and held in place by the clamps shown in cut.

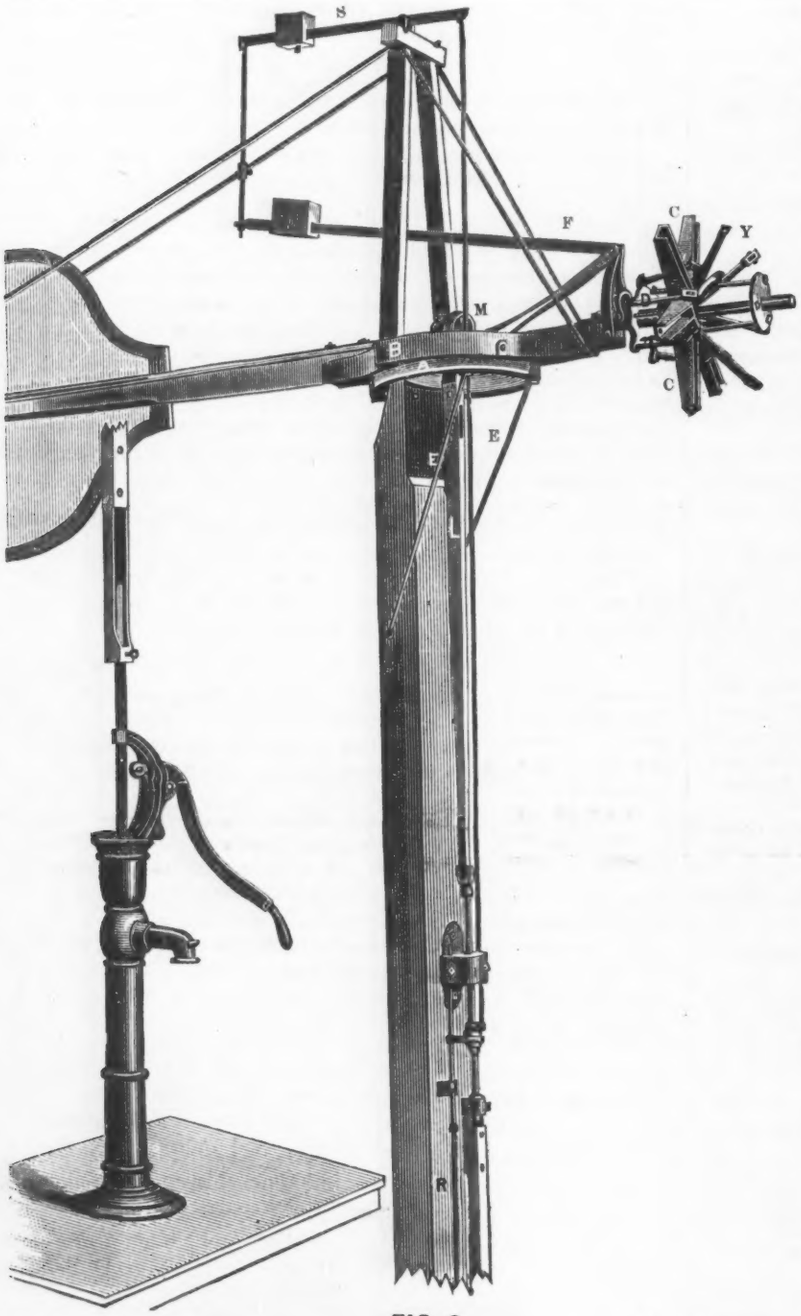


FIG. 2.

C, is a spider, to which are bolted the arms or spokes of the Wind Wheel. This is firmly keyed to the shaft, which rotates in boxes lined with Babbitt metal, and fixed on the Turn-Table. This shaft terminates at the centre of the Turn-Table, carrying the Crank Plate *M*, to which is attached the pitman *L*, which operates the Pump. The peculiarity of Halladay Wind Mill is the arrangement of its regulating gear, consisting of the sliding-head and connections with the wings of sails.

The Sliding-Head *D*, is connected to the elbows *Y*, by a link from each. To the outer end of the elbows *Y*, are fastened rods which are attached to the centre of each wing, operating the same out or into the wind as the Bent Forked Lever *F* is raised or depressed. These rods carry at their outer ends weights, which, by the centrifugal power, also turn the wings out of or into the wind, thus confining the Mill to a safe motion in violent wind storms. The action is the same as that of the governor on an ordinary steam engine.

This arrangement is simple, securing a *direct* connection with each wing, and *direct* action of the regulating weights on the Sliding-Head and its connections, thereby giving positive movement to all the parts.

As this mill is in extensive use throughout this and the adjoining States, and apparently gives good satisfaction where it is used, it was selected as an example of a modern windmill to compare with the Dutch Mill of which dimensions and performance have been given above.

From the published catalogue and price list it appears that three descriptions of mills are made, for farm pumping (1), for railroads (2), and for driving machinery (3).

The first class comprises 6 sizes of from 8 feet to 14 feet diameter of sails, and 400 lbs. to 1440 lbs. in weight. The second class comprises 7 sizes of from 16 to 30 feet diameter and 1895 lbs. to 3866 lbs. in weight. The third class includes 8 sizes of from 16 ft. to 60 feet diameter, and 2 H. P. to 40 H. P. in power. No. 9 in this class has a wheel of 25 feet diameter and is tabulated as of a 6 horsepower.

The effect of the Dutch windmill described above is equivalent to 6.6 H.P., therefore by Smeaton's 8th principle, the diameter of a Halladay's windmill of 6.6 horse power will be $= \frac{(25)^2 \times 6.6}{6} = 26.2$ feet nearly.

A modern mill therefore of 26.2 feet diameter is equivalent to an old Dutch mill of 40 feet diameter; and the mechanism at the head being simpler, the apparatus for folding or unfolding the sails being also simpler, and the sails being of wooden slats instead of canvass, the modern mill must necessarily cost less to construct than the Dutch Mill, and the principle thereof should be followed in constructing windmills in preference to that of the latter which is useful however for the purposes of study and comparison.

An expedition is being organized in Egypt for the purpose of examining the geological and physical constitution of the valley of the Nile, and of the land bordering on the Red Sea. The most important question to be determined is the possibility of establishing a branch of the river in the ancient bed of a stream occupying the base, or the valley called by the Arabs the Valley of the Dry River. If this work can be accomplished, a large amount of now waste land will be rendered suitable for agriculture.

ANSWERS TO CORRESPONDENTS.

MESSRS. EDITORS.—I would respectfully say that I concur in opinion with your correspondent "H. W." of Waukegan, Ills., in regard to the sub- of fractional sections where no opposite corresponding corners have been, or can be set.

I have always made it an invariable rule to run the *interior* lines of *interior* sections by intermediate courses, and those of the north and west tier of sections by running lines parallel with the east and south lines of the section; but meeting with some opposition, I desired the opinion of other surveyors.

Owing to the unreliability of the magnetic needle, I deem it necessary to ascertain the proper courses by careful chaining with a *two*-rod chain across the section, and not depend wholly upon the needle. And in cases where the section is crossed by a meandering river, and where the surveys upon each side were separately and independently made, and the section lines are not continuous, I subdivide the fractions upon either side of the river independently according to the above rule.

QUES 1. Will you please publish a reliable rule for finding the legal position of the interior quarter quarter posts which are to be established upon the quarter lines between the interior and exterior quarter corners upon the township lines, in the west and north tier of sections?

QUES. 2. Can a Government quarter corner be legally identified in case only one bearing tree remains and no trace of the other can be found? If so, what variation of the needle should be adopted in establishing the same, that of the true meridian or that of the true boundary upon which the quarter corner stands? J. M., Shawano, Wis.

For the answer to No. 1, we would refer our correspondent to the communications published in answer to correspondents, and the U. S. Land System, in our last number. In reply to No. 2, it is our opinion that the corner could be established from one "witness tree," and the variation to be adopted would be that of the section line. EDITOR.

WAUPACA, WIS., July 20th, 1874.

MR. EDITOR.—In reply to "J. B."'s letter of July 7th, I am of the opinion that a survey cannot *fix*, or unalterably establish a line, unless said survey is in accordance with U. S. Laws, and Instructions from the Secretary of the Interior.

In Iowa, 10 years undisputed possession of land, gives the possessor a valid title to said land.

In Wisconsin, 20 years does. If 25 years is required in Michigan, and those fences have stood 25 years, as acknowledged boundaries between the parties interested, then they are legal boundaries; and they would be just as much so, if the survey mentioned *had not been made.*

This raises the question as to what should be done with the positions of land lying between said fences, and the legal subdivisional lines of said section? Ans.—Nothing while the present owners hold the land. If the party who has acquired land by possession wishes to sell, I think it necessary, in order to convey said acquired land, that he should give a separate description of it, when making out his deed to the parties who buy of him

The party losing by the aforesaid improper survey, should, if he sells, except, by description, the land so lost.

If, in selling, he should copy the description given in his old deed, he will deed land that does not belong to him—land that he has lost by allowing his neighbor to retain undisputed possession of it for a prescribed number of years.

Will "H. W.," of Waukegan, Wis., please state what course he would pursue in regard to "closing the survey, and establishing the opposite corner," if his section was made fractional by Lake Michigan? Also whether the same principles would not apply in any other fractional section, no matter how small or narrow the meandered lake or river, by which said section was made fractional?

Yours respectfully, B. F. D.

In reply to the question whether 21 or 25 years undisputed possession in Michigan gives title, we would say that 21 years being the usual time in most of the States, we suppose it prevails there. If the law is different we would like to be informed on the subject. EDITOR.

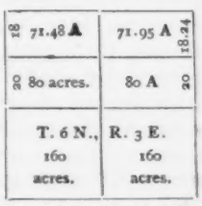
ROCHESTER, MINN., Aug. 3, 1874.

MR. EDITOR.—In your last issue your correspondent "J. B.," of Morenci, asks, "when a section has not been correctly subdivided, can the stakes be changed?" Undoubtedly they can—no corners or lines (Government corners and lines excepted), are unalterable, I care not by whom set or run, if found to be incorrect. It is the province and duty of a surveyor to make a correct subdivision of the section and quarter sections regardless of previous surveys, or the occupancy of parties.

If either party thinks he can hold by right of possession, let the courts decide that matter between them, if the party choose to appeal to that tribunal.

I perceive by the tenor of his remarks that "B. K.," of Adrian, Mich., advocates, in the subdivision of a quarter section, the running of a straight line from the quarter quarter corner on the section lines across the entire section, to the corresponding quarter quarter corner on the opposite side of the section both E. and W. and N. and S., and thus fixing the centre of the quarter section at the intersection of these lines while others advocate the similar quarter quarter corners on the four sides of the quarter *section* after the centre of the section has been fixed: thus making the subdivision of each quarter independent of the rest of the section. This is a question which, I believe, has never been fully settled, either by the courts, or among surveyors. The different Surveyors General differ on this point as do also the Commissioners of the General Land Office, and as the law on on this point is capable of different constructions, I would like to see the question discussed from different stand points and if there are any decisions on this point, would like to see them produced. For want of any better authority, I follow the laws of our own State (Minnesota), which directs the subdivision of a quarter section by the latter method.

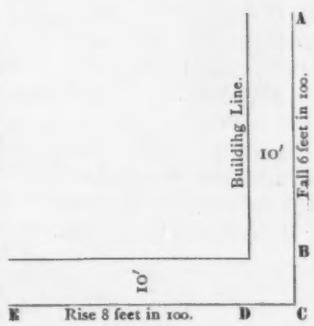
T. H.



PULASKI, WILLIAMS CO., O.

MR. EDITOR.—Section One of Pulaski Township is marked on the Government plats as shown on the annexed diagram. The N. W. ¼ containing 151.48 acres, and the S. W. ¼ containing 160 acres were originally owned by one man who selling, gave a deed *first* for the N. W. ¼ of the N. W. ¼, 37.87 acres more or less, and *afterwards* gave a deed for the S. W. ¼ together with the S. W. ¼ of the N. W. ¼, 200 acres more or less; a surveyor, three years ago, in dividing the section ran north a full 20 chains from the quarter post, paying no attention whatever to the deed first given which method I hold to be wrong, but rather that the W. ½, N. W. ¼ should be evenly divided. I would like to have the opinion of others on the subject. I wish to add as an item of information that the original survey of Pulaski Township was fraudulent, no corners being set and the Deputy Surveyor returning forged field notes. Corners now are determined only by the intersection of blazed lines.

E. B. O.



MR. EDITORS:

Will you please answer through the columns of your journal, the following question in reference to the establishment of grades. The above diagram represents the intersection of two streets, and A C E the curb, the grade of which from A to C is 6 feet to the hundred, and from C to E the grade falls 8 feet to the 100. Now it will be seen that the grade, at the point D will be (making the sidewalk 10 feet wide), 1.4 feet lower than at B, in which case making the sidewalk at B level, you would have to give it a slope of 1.4 feet at D which would be very steep. Would it not be better to break the grade at the points B and D, making them almost level, so as to give to the sidewalk its regular slope, or very near it, than to continue the 6 and 8 feet grades on to the corner of the sidewalk, and thus warp the sidewalk? R. H., Chattanooga, Tenn.

ANS. To break the grades at the point B and D as "R. H." suggests, appears the best solution of the problem. EDITOR.

ELECTRICAL RESEARCHES.

Sir William Thompson, the eminent scholar, has recently been agitating, before the telegraphic engineers of England, a novel and comprehensive plan for researches in terrestrial electricity. It has now been nearly three centuries since Gilbert, the contemporary of Galileo, declared that the earth itself was a great magnet. But, though laboriously attacked by the astutest minds of modern science, the problem he suggested, and the numerous kindred inquiries relating to practical matters of terrestrial and atmospheric electricity and the laws of magnetic variation are as yet in a maze of scientific obscurity. The violent magnetic storms which derange our telegraphic wires, as well as the ever-changing secular and annual oscillations of the mariner's needle, are still mysteries, and need elucidation. Sir William Thompson, who has had so much experience as the scientific director of the Atlantic cable-laying parties, proposes a simple and inexpensive method of obtaining the electric data requisite for clearing up these mysteries, which now so befog the mariner and telegrapher.

The first point to be elucidated is the strange secular vibration of the compass. In the middle of the sixteenth century the needle pointed toward the northeast; after a few years it pointed due north; then, till 1870, its direction was west of north, and it is again returning north. It is confidently asserted by electricians that the dip of the needle is, within the two next centuries, to be greater than it has been for a thousand years, or will be for another thousand years. Then the northern magnetic pole will lie a little to the west of Spitzbergen, instead of, as now, in Boothia, latitude 78° north, longitude 94° west, where the nomadic point is nearly identical with the pole of maximum cold. This shifting of the north magnetic pole is, therefore, over 65° of longitude, or more than one-quarter of the terrestrial parallel. Great as is this variation, necessitating as it does, a continuous alteration of the magnetic charts, it might be of secondary importance if it stood alone. But it is not the only nor most important perturbation which the needle undergoes. More rapid diurnal and even horary changes occur, apart from all local causes, and apart from all disturbing forces, which sometimes lurk unsuspected on board ships. Between the tropics the hour of the day, we are told by Humboldt, may be quite nicely told by the direction of the needle. There are also localities where the sailor, who has been many days enveloped in mist, and denied all means of determining the time, may know from the varieties in the inclination of the magnetic needle whether his ship is north or south of the port he is trying to enter.

But the magnetic storm, suddenly bursting on him, may at any time, and in a way not now understood, deflect and derange all his calculations and courses. The flash of the northern light is the signal for still greater disturbances in the directive force, the auroral waves constantly causing violent agitation and forcing the needle to make irregular oscillations on each side of its mean position. During the auroral displays of September, 1859, the agitation extended, as it usually does, over vast sections of the globe where the display itself was not visible. On that occasion, at Toronto, the needle changed three degrees and forty-five minutes in half an hour; the inclination was observed to change nearly three degrees, when it passed beyond the limit of the scale; while, elsewhere, equal or greater perturbations were recorded. These phenomena are among the greatest mysteries of science; but if Sir William Thomson's plan of investigation can be carried out, their solution is by no means hopeless. He proposes that practical telegraphers devote a little of their leisure time to simultaneous observations of the earth's currents. The one common link connecting the phenomena, and bringing them within the scope of observation, is the electric telegraph, whether an air line or submarine. And the eminent electrician judiciously recommends the operators to give the matter their study, assuring them that any single observation or series of observations on the electric potentials at one end of an insulated line will give results from which definite answers to the long-mooted questions might be fairly concluded.

It would not be the least of the many great benefits that the electric telegraph has conferred on the world, should its practical workmen thus utilize its agency for solving the great problems Sir William Thomson has propounded. If abstract science gives so many practical inventions to the arts, we know that the simplest mechanical contrivance has often led the philosopher into new worlds of discovery. There is no reason why in this case, the electric telegraph should not requite fourfold the science which gave it existence. Prof. Thompson's appeal suggests a line of profitable occupation for the many active and thoughtful telegraphers in the employ of the large companies.—*New York Herald.*

Steam Towage on Canals.—Some time ago a prize of $100,000 was offered by the State of New York, to the most successful inventor and maker of a motive power for canal boats, other than the present system of towage by water. Some 2,000 plans were sent in, but of these fully one-half were absurd, and at least nine-tenths of the remaining one-half were only on paper; some sent models, but only 40 or 50 boats fit to navigate canals were sent in. The conditions of the competition were a cargo of 200 tons on a 6 feet draught, with a speed of 3 miles per hour; cost to be less than that of horses, and the method to be easily applied to existing canal boats. The successful competitor was William Baxter, whose boat had a speed of 3.09 miles per hour, and carried 200 tons of freight, in addition to her machinery on a consumption of 45 lbs. of coal per hour. Horse tonnage costs on the Erie canal at a speed of 1¼ mile per hour for a distance of 60 miles, 2 cents per ton of freight. The Baxter steam tonnage system costs per ton of freight carried per 60 miles, at a speed of over 3 miles per hour, 1 cent; relative economy between this system and that at present in use, being one-half the cost for double the speed. The saving on the Erie Canal alone in adopting this system, is estimated at $4,000,000.

The Erie Canal carries about ⅔ the freight on the canals of the United States, therefore the saving on all the other canals may be estimated as half as much again as the amount to be saved on the Erie Canal, or $6,000,000; making a total saving to the whole coontry of $10,000,000.

The increase in speed over ordinary tonnage also *doubles* the capacity of the canals, and this will lessen rates of freight and re-act upon both the Western producers and the Eastern consumers, enlarging the market to the former and decreasing the price to the latter.

LAW AND LEGISLATION.

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc.

74. When lands are described in a deed or grant as bounded by a river not navigable, the centre of the stream is to be considered the boundary. Clarement v. Carlton, 2 N. Hamp., 369. Palmer v. Mulligan, 3 Caines (N. Y.,) 407, 319. Hayes v. Bowman, 1 Rand. (Va., 417.) Ingraham v. Wilkinson, 4 Peck. (Mass.) 268. Gavil v. Chambers, 3. Ham. [Ohio.], 496. Browne v. Kennedy, 5 Har. & J. [Md.], 195. Arnold v. Mundy, 1 Halst. [N. J.], 1.

75. And this rule holds though trees standing by the side of a river are named as the points for beginning and ending. Lunt v. Holland, 14 Mass.. 151.

76. It is otherwise where land is bounded on a navigable river, in which the tide ebbs and flows. *Exparte* Jennings, 6 Con. [N. Y.], 518. Middleton v. Sage, 8 Conn., 221.

77. One owning land, through which a mill stream flowed, granted all that part of it which was situated east and north of the stream. It was held that the boundary was the centre or thread of the river. Morrison v. v. Keen, 3 Greenl. [Me.], 474.

78. Where land lying on each side of a river was owned by tenants in common, and they made partition of the same by assigning the land on one side of the river to one, and that on the other side to another, it was held that the thread or centre line of the river would form the boundary between the tracts. King v. King, 7 Mass. 496.

79. Grant of land adjoining land by the state, and occupation under them, and subsequent conveyances by the grantees, referring to monuments not existing at the time of the original grants, are admissible in evidence for the same purpose. Owen v. Bartholomew, 9 Pick. [Mass.], 520.

80. A common practice of surveyors of land laid out by the proprietors of a town, to overrun the exact measures, is admissible to show that the boundaries of an ancient grant by the State, in an adjacent town, described by courses and distances, exceeded the distances given. Owen v. Bartholomew, 9 Pick. [Mass.], 520.

81. Acquiescence for a long time, (e. g. for 18 years,) even in an erroneous location, is conclusive on the party making or acquiescing in such location. Rockwell v. Adams, 6 Wend. (N.Y.), 469.

82. Where a boundary is disputed between parties who own adjoining tracts, and the parties employ a surveyor, who runs out the line, and marks it on a plat in their presence, as a boundary, after 20 years corresponding possession, they are concluded by it. Boyd v. Graves. 4 Wheat,, 513.

83. Where the lines and boundaries of land are fixed and and established and can be identified, a verbal agreement to fix the lines or boundaries different, is within the statute of fraud, and void. Nichol v. Sytle, 4 Yerg. (Tenn.) 456.

84. But where there is a doubt of the identity of the dividing lines, the parties may establish their lines by a parol agreement. Houston v. Matthews, 1 Yerg. (Tenn.), 116. Boyd v. Graves, 4 Wheat., 513.

85. Boundaries may be proved by hearsay evidence. Boardman v. Reed, 5 Pet., 341. Jackson v. McCall, 10 Johns. (N.Y.,) 377. Not however unless it amount to common tradition or report. Cherry v. Boyd, 6 Litt. (Ky.), 7.

86. The declarations of deceased persons as to boundaries of land, are not admissible when it appears they had, from their situation, an interest to make the declarations. Shepherd v. Thompson, 4 N. Hamp., 213.

87. Reputed boundaries are often proved by the testimony of aged witnesses; and the hearsay evidence of such witnesses has been admitted to establish the real lines, in opposition to the calls of an ancient patent. Conn. v. Penn, Peters, C. C. 497. See Weems v. Disvey, 4 Hart. & McHen. (Md), 158.

88. A grant calling west, north; and east, south; and south, east, may be obviated by the marked lines and corners, and other objects described and found on the ground. Woods v. Kennedy, 5 Monr. (Ky.), 176.

89. Evidence of the possession of settlers on adjacent tracts, in reference to a division line, attempted to be shown as recognized by one of the parties in a suit, is admissible, Rockwell v. Adams, 6 Wend. (N. Y.), 467.

90. The annulations in the line trees and corner trees, are evidence entitled to great weight. Bulor v. McCawley, 3 A. K. Marsh (Ky.), 576.

91. In questions of boundary, if grants will adjoin each other and harmonize with old lines, it is very strong evidence that such lines were the lines of the grants. Bowman v. Cox, Peck, (Tenn.) 364.

92. If a survey has been made by a public officer, a subsequent private survey cannot be given in evidence. The party should apply for a re-survey. Cecil v. Amberson, Addison, (Pa.), 359.

93. A safe rule. in questions of boundary, is, to compare the calls in the grant with the artificial and natural marks found on the ground, and if there be a fitness, it is better to rely on the evidence they afford, than on the proof of loose statements about boundary. Payton v. Dixon, Peck, (Tenn.), 148.

94. It may be left to a jury to presume a line not called for in the grant, where there is a corner marked at which such line might terminate, and a line agreeing with the grant extending from such corner. Jordan v. Payne, Peck, (Tenn.), 320.

95. Where the original boundaries of a tract of land cannot be found, and it is afterwards resurveyed, if the resurvey reasonably conforms to the calls of the grant, the grantee will hold the land contained in the resurvey against the state, or persons who have entered the land after the resurvey. Garner v. Morris, 1 Yerg., 62.

96. If the grantee cause the lines to be run and marked in reasonable conformity to the calls of the grant, though they were incorrectly marked, yet if done in honesty and good faith, such re-marking is good against the State and subsequent enterers; and after the grant is plainly marked out, the owners thereof are estopped to claim the boundary they themselves have made. Davis v. Smith, 1 Yerg., 496.

97. To establish a beginning and other corners of a grant, it is not indispensably necessary that they should be marked, if they can be established by other descriptions sufficiently certain to enable the surveyor, chain-bearer, &c., to find them. Rucker v. Vaughan, Peck., (Tenn.), 272.

98. If, in running the lines of a grant, one line be found marked, which is admitted or proved to be a line of the grant, and which will run with a variation from the calls of the grant, if no other marked lines be found, the other calls should be run with the same variation as that found on the marked line, to ascertain the land granted. Sevier v, Wilson, Peck, 146; see also Lewis v. Harwell, Peck, 295.

99. The rectangular figure will be preserved in preference to any other in fixing locations. Massie v. Watts, 6 Cranch, 148; see Holmes v. Trout, 7 Pet., 171.

100. "Seventy acres, being and lying in the south-west corner" of a section, is a good description, and the land will be in a square. Walsh v. Ringer, 2 Ham. (Ohio), 327; see Cockrell v. McQuinn, 4 Monr. (Ky.) 63.

101. The proprietors of land bounded on a highway have, prima facie at least, a fee in such highway, *ad medium filum viæ*, subject to the easement. Chatham v. Brainerd, 11 Conn., 60. Jackson v. Hathaway, 15 John, (N. Y.), 447; Peck v. Smith, 1 Conn. 103; Cortelyon v. Van Brundt, 2 Johns. (N. Y.) 357.

102. A survey made by a deputy surveyor, out of his district, is void, and the patentee cannot recover in ejectment. Griffith v. Tunckhouser, Pet. C. C. 418.

103, A survey made by one who is not an authorized deputy surveyor, but employed by the Surveyor General, is admissible in evidence, if accepted by the Surveyor General. Burd v. Seabold, 6 S. & R. (Pa.), 137.

104. A warrant directed to one surveyor cannot be executed by another without his authority. Nicholas v. Holliday, 3 Yates, 399. The line of a survey may be extended before it is returned, where no injury is done to other claimants. *Ibid.*

Book Notices.

The Construction of Mill Dams. James Leffell & Co., Authors and Publishers, Springfield, Ohio, and 109 Liberty Street, New York City. Price, postpaid, $2.50.

This is the title of a neat 8vo. volume of 312 pp., well printed on toned paper and abundantly illustrated with wood cuts which with the letter press fully describe the numerous designs represented. The book is in fact a reprint of a series of articles on the construction of dams which have appeared from time to time in Leffel's Illustrated Mechanical News, and which are still being continued therein. An eminently practical work on dams in which the details of construction are clearly shown has long been wanted and this work goes a great length if not quite all the way towards supplying the want. Examples of dams in all of the three materials, timber, iron and stone and also in combinations of timber and stone, are given in plenty. The work is divided into fifty-two chapters of which the first three are introductory upon the materials and forms of dams, and with an illustration of the natural dams constructed by those clever builders, the beavers. Chapters 4 to 47 inclusive are taken up with the description of the various dams illustrated and others, each chapter being illustrated by one full-page wood-engraving and in some cases the construction of the dams is still further shown by cuts similar to those below which have been kindly lent to us by Messrs Leffel. The remaining five chapters describe reservoir embankments and the difference between them and dams across running streams, head-gates for races, and methods of guaging the supply to water wheels and of measuring the flow of water in the open channels of streams and rivers. Among the largest and best known dams illustrated and described are the great Housatonic Dam, at Birmingham, Conn., which is of solid masonry, 870 feet long and 22′6″ feet high and contains 451,000 cubic feet of masonry, giving 2500 H. P. for 12 hours per diem with the minimum flow in the river of 500 cub. ft. per sec.; the great Moline Dam, 2400 feet long and 20 feet high, situated on the Mississippi, at Rock Island, Ills.; the Dam across the Kansas River, at Lawrence, Kas., which is 700ft. long and 8ft. high, and which provides 2500 H. P.; the Locks and Dam at Henry, Ill., which dam constructed of timber, is 540 feet long, 11 feet high and 36 feet wide at the base; the great timber dam at South Hadley Falls, Mass., which is 1017 feet long and 28 to 32 feet in height, and required 4,000,000 cub. ft. of timber for its construction. We are sorry that we have not space to give one of the full-page engravings which so profusely illustrate the work, but we give below two extracts with wood-cuts which will fully show the practical character of the book. Fig. 1 represents one of the "bents" of a small dam over the Little Miami River near Clifton, Ohio. The dam is about 100 feet long and is laid and abuts upon solid rock.

"The foundation of the dam consists of six sills, 10 by 14 inches crossing the stream, and placed from 6 to 8 feet apart, being somewhat nearer together under the apron than beneath the main structure of the dam. The ends of the sills are mortised into the rock at each bank, the sill farthest up-stream being also imbedded in the rock for its entire length. Across these sills are laid timbers 10 by 14 inches and about 40 feet long, the distance between centres being about 6 feet, They are secured to the lower or foundation sills by 1¼ inch barbed iron bolts, 2 feet long. Both these courses or layers of logs are squared on the top and bottom. The two centre sills running lengthwise of the stream, and situated at the angle of the dam, are bolted together

Fig. 1.

The breast of the dam is raised at the fourth foundation sill, counting from the up-stream side. The upright posts constituting the front of the dam are 12 inches square, about 15 feet long, and have an inclination from perpendicular about 3 feet up stream. The posts at the centre or angle of the dam, like the two upper sills at that point, are set close together and bolted to each other. The whole number of posts is the same as the number of upper sills, and they are placed the same distance apart, each post resting on a sill, into which its lower end is mortised. Upon the top of the posts, crossing the stream, is a cap timber 12 by 14 inches. This cap timber is in four pieces, each 25 feet long, spliced where they connect, and mortised into the rock at each bank. The upper ends of the upright posts are mortised into the cap-timber.

The rafters composing the up-stream slope of the dam are 10 inches square and some 25 feet long, and equal in number to the posts—each rafter, with its corresponding post and the interior braces, constituting a "bent." The rafters are mortised into the cap-timber, and between them are short cross-timbers or ties, 10 inches square, mortised into the sides of the rafters, and flush with their upper surface. The same description of ties are placed between the upright posts. The purpose of these ties is to give firmness to the frame, and prevent any tendency of the bents to sway or spread to or from each other. There are three of these ties between each pair of rafters and two between posts so that each bent is connected with the next by five ties, the distance between the ties being from 6 to 8 feet. The foot of each rafter rests upon one of the upper sills, and a bolt is driven through the rafter and upper sill to the foundation sill of the dam.

This slope of the dam is covered with two coats or courses of 2-inch oak planks, joined in the usual manner, the first course being laid crosswise of the stream, and the second or top course lengthwise, in the same direction as the rafters. The planks are secured by spikes, and the top course footed at the lower ends of the planks against a sill running across the stream the whole length of the dam.

In the interior of the bents are braces 10 inches square, mortised into the posts, sills and rafters, in the manner and position indicated in Fig. 1.

The apron is constructed by placing transverse or cross sills upon the longitudinal or upper sills of the dam, these cross sills being three in number and about 6 feet apart. Upon these sills are laid timbers of the same size, lengthwise of the stream, hewed on two sides and laid close together. These logs forming the apron, are 17 feet long. At their upper ends, where they meet the breast ot the dam, a cross-timber is laid on, running the whole length of the dam, and beveled on its front so as to leave its top only 2 inches wide. The cap timber at the top of the posts alsc projects 2 inches, and the 2-inch planks constituting the face of the dam, which are spiked in an upright position upon the posts and cross-ties, make with the 2-inch projections at their top and bottom, against which they rest, a continuous smooth face to the dam, giving the water an unbroken and even fall.

All the sills, rafters, and ties composing the framework of the dam are white oak, secured by iron bolts.

The interior of the crib-work composing the apron is filled compactly with stone. The interior of the dam is also filled with stone, about half way to the top; and against the up-stream slope of the dam is a filling of gravel and clay, extending from some 15 feet above the dam to a point half way up the slope, thus covering the entire lower part of the planking.

The ground plan of the dam is such that it makes an angle with the apex up-stream, instead of the arch or curve often used. The angle is but a moderate one, the centre of the dam being but about 4 feet farther up-stream than the ends, while the entire length, as already stated, is about 100 feet. As will be seen by the dimensions already given the base of the dam, inclusive of the apron, has a total length of about 40 feet.

Near the centre of the dam is a waste-way regulated by a sliding gate on the upper side of the dam.

The height of the dam from the apron up to the crest is about 14 feet, the 15 feet posts having a slight inclination, as already stated. The height from the rock bottom to the top of the dam is 17 feet or thereabouts, the top of the apron being three feet or more above the rock.

This dam was built nearly three years since by Messrs. King & Hagar, at that time proprietors of the Clifton Paper Mills.

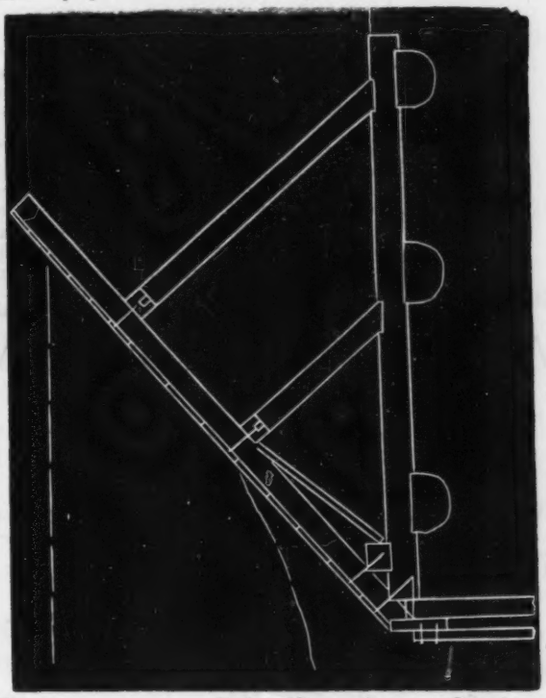


Fig. 2.

Fig. 2 represents a light frame dam at Stephentown, N. Y., 264 feet long, or including abutments, about 300 feet, and 7 or 8 feet high to the water line.

The stream is a small and fluctuating one, and has a bottom of clay, gravel, and mud. The object of the builder was to construct a tight dam, entirely of wood, to form a reservoir. The area of the reservoir thus obtained is about 8 acres.

The foundation consists of three rows of large elm logs or mud-sills, laid cross-wise of the stream, about 4 feet apart, each log from 12 to 24 feet long, as convenient; the logs of each row breaking joints with those of the next row. These are laid in trenches from 2 to 3 feet deep. Across these mud-sills are laid the cross-sills, lengthwise of the stream, 12 feet long, 9 inches square, and placed 6 feet apart. These sills are notched 1½ inch on the bottom, where they cross the three mud-sills, and pinned with 1½ inch pins; the mud-sills are slotted from 3 to 6 inches deep, and faced on the up-stream side; the cross-sills are also notched 1¼ inches deep on the top, a little up-stream from directly over each mud-sill, to receive the foot of the posts and the lower plate.

The post, or braces, of which there are two courses, are 6 by 7 inches, the wide way being put lengthwise of the dam, and are pinned at the foot with 1¼ inch pins, without tenoning; there are three plates running lengthwise of the dam and supporting the rafters, each plate consisting of pieces 12 feet long, put in to break joints; the lower plate is 8 inches square, and rests directly on the cross-sills at the up-stream foot of the dam, in the 1¼ inch notches before mentioned; the middle plate is 7 inches square, and rests on the short posts, which are about 3 feet long, a 1½ inch tenon being made on the upper end to hold the plate on, and a ¾ inch pin put in; the upper plate is 6 inches square, resting on the long posts, which are about 6 feet in length, and framed and pinned in the same manner as the short posts; the distance between the lower and middle plates is about 3½ feet, and between the middle and upper plates 4 feet; the posts are set at right angles with the rafters, and at an angle little less than 45 degrees with the cross sills. Braces 4 and 5 inches square are also put in between the middle and lower plates, over the cross-sills.

The rafters are 4 by 5 inches, and 3 feet apart between centres, every alternate one being over a post and cross-sill, and pinned with 1-inch pins. The lower ends of the alternate rafters are notched over the up-stream ends of the cross-sills, and pinned, so as to bind all firmly together; the frame work is all red oak; the planking is chestnut, 2 inches thick for about two-thirds of the height from the bottom, and 1½ inch thick for the other third. Every plank is grooved, and tongues of oak ½″ by 1¼ inch put in. This the builder considers a very important item in a tight dam. The planking in the abutment is also tongued, and even the spiling at the bottom. The planks are only 6 feet long, and are thoroughly pinned with ¾ inch oak pins.

At the up-stream ends of the cross-sills there are short oak posts driven down in the ground (of the same size as the rafters, 4 by 5 inches) and pinned at their upper ends to the cross-sills to which are spiked 2-inch planks 12 feet long; to these the upper end of the spiles are spiked, the planks also forming a tight joint at the angle between the spiling and planking. The spiles are of 1½ inch chestnut plank, tongued—though any kind of wood will answer, as being entirely under water at all times, it will last an indefinite period. The piles are 4 feet long, more or less, according to the kind of bottom in which they are driven, and are sharpened on the flat sides and driven tight together. This is a slow and tedious process, but is of vital importance.

The ends or abutments are formed by perpendicular posts and planking, even with the foot of the dam, similar to the rafters and planking of the main dam, extending 12 feet into the plank at the west end. Below, or on the down-stream side of this upright part, there is a solid bank of dirt and brush filled in, about as high as the water line, some 10 feet thick, and very firm and compact There is also a filling of mud, dirt and gravel on the water side of the abutment, and along the whole length of the dam, extending about 3 feet up the planking.

The apron is 90 feet long, and, as will be seen in the illustration, its upper edge is even with the upper plate of the dam. There are at present no flash-boards, but it is the intention of the owner to put them on the coming season. The apron is planked directly on the main posts of the dam, (which are supported by braces between the middle and upper plates) with 2-inch planks, so that the water will slide instead of falling over it At the bottom are 12 feet planks 3 inches thick, placed lengthwise of the stream on two long mud-sills, their upper ends resting on the third or down-stream mud-sill of the main dam, and pinned with 1-inch pins. At the foot of the posts, across the 3-inch planks, is a 2½ inch oak plank to receive the force of the descending water and the shock of flood-wood coming over the apron. One tenth of the capacity of the apron will carry the stream at ordinary stage, but it sometimes rises very rapidly and to a great height.

No spiling is considered necessary at the lower end of the apron.

About 22,000 feet of lumber was used in the construction of this dam, valued at $550, and the cost of labor was about $950, making the total cost of the dam $1,500. The builder is confident that a cheaper dam of the length and size could not well be made, light timbers being used throughout."

We cordially recommend this book to all whose practice embraces the construction of dams, weirs or kindred works; the theorist will find in it a large collection of practical examples of successful dams and the "practical man," many with which he may not be familiar. We note with favor that in most cases the *reason* for adopting that particular form of dam under the given conditions, is fully explained.

ADVERTISEMENT.

Throughout the United States and the Dominion of Canada, there are certain places which, by their location and natural advantages, are peculiarly adapted to the development of some great manufacturing enterprise. There are mineral regions which only need to be placed in a strictly truthful position before the public to be appreciated and attract the attention of capitalists. There are great tracts of agricultural and grazing lands in the South and West which are practically unknown, but which, if properly brought to the notice of the right parties, would soon create a demand therefor, and ultimate settlement.

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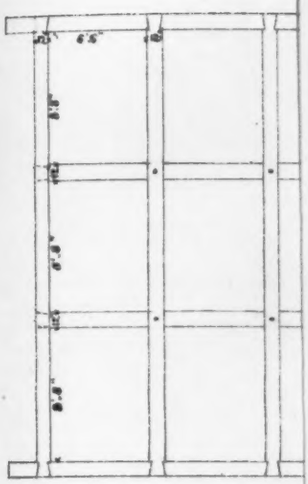

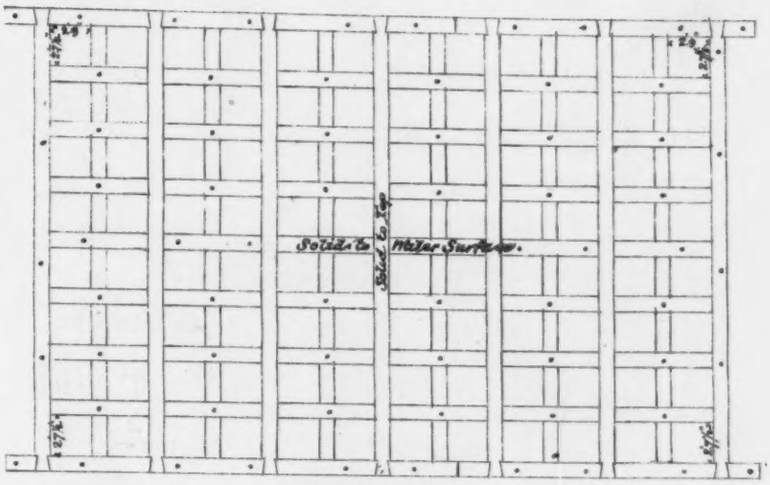

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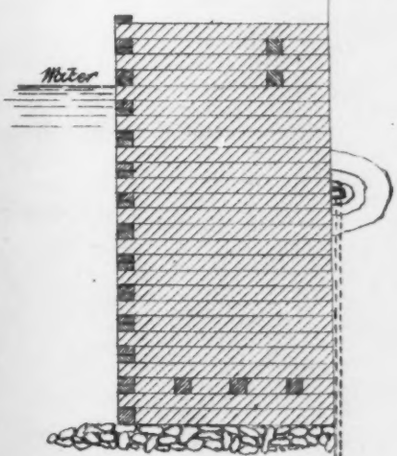

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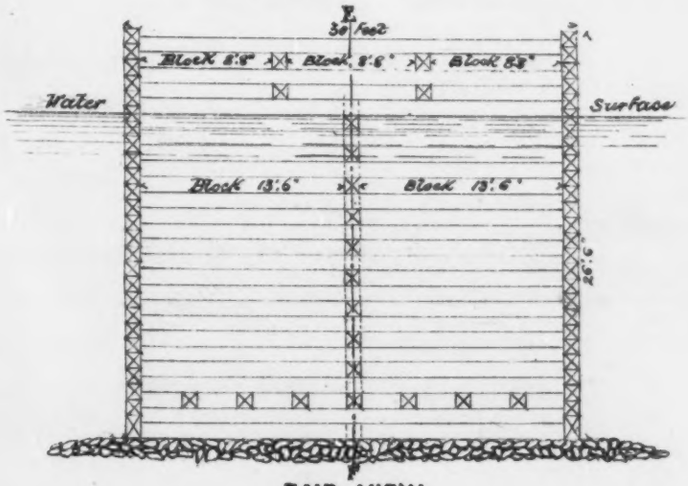

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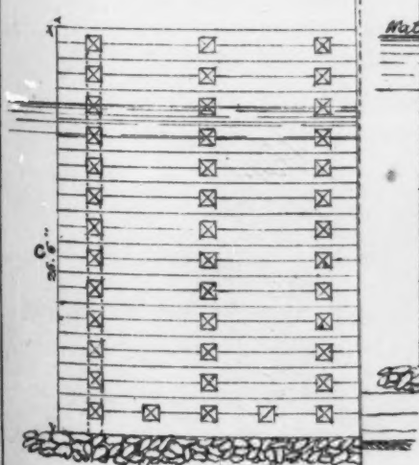

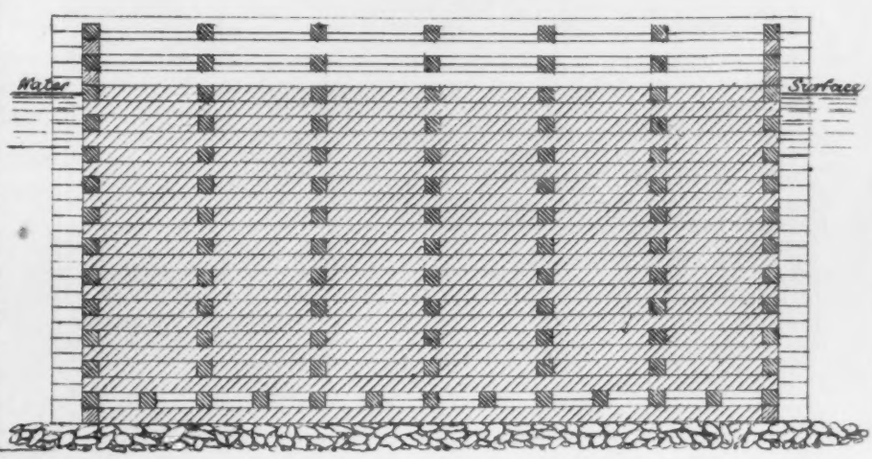

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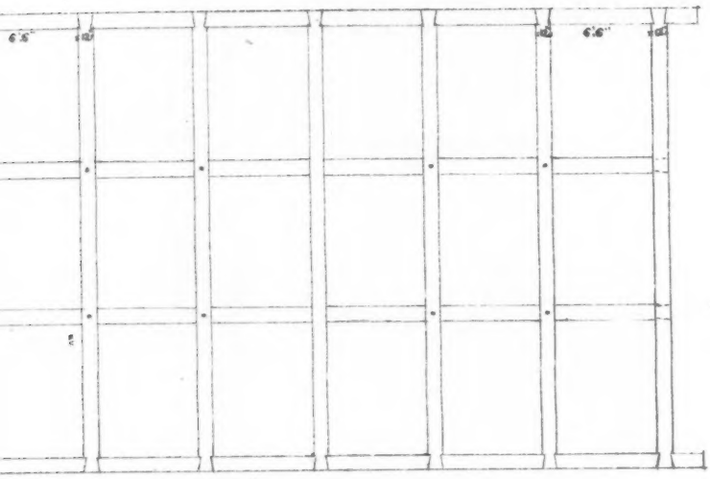


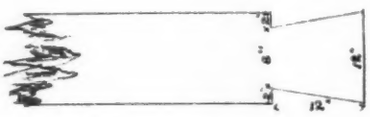
PLAN OF CRIB

Scale of 1/4 to Drawings of Crib

FEET 10 5 0 10 20 50

FEET 1000 500 0 500 1000 1500 200

Scale of 1/3600 to General Plan of Harbor.



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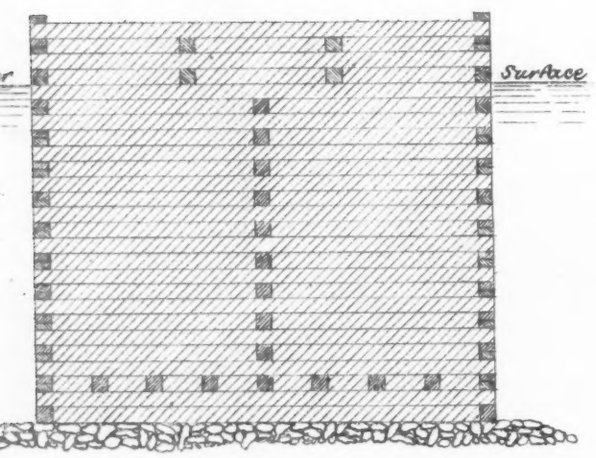

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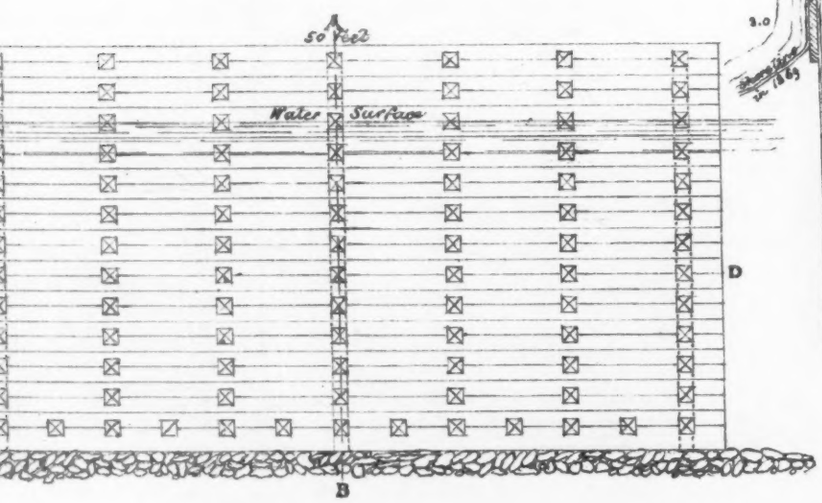

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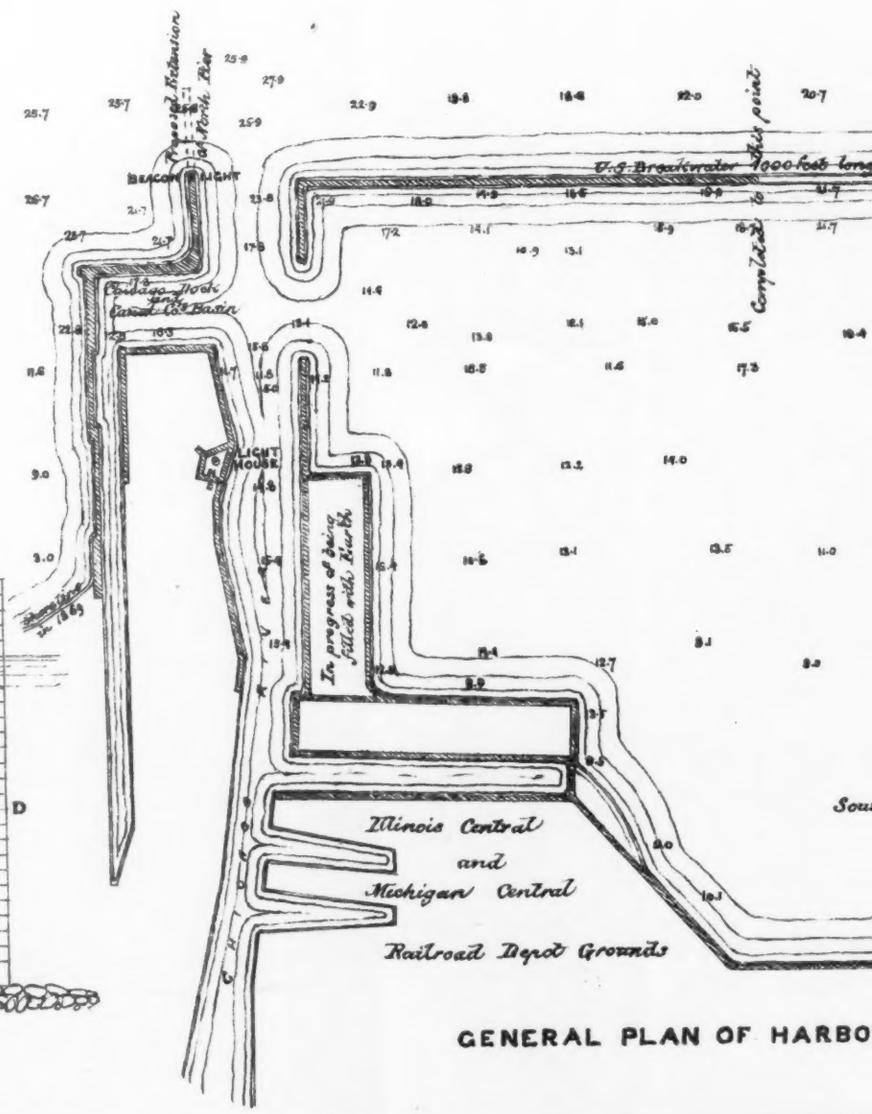

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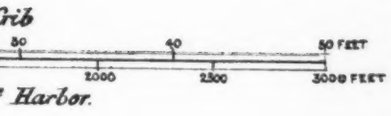

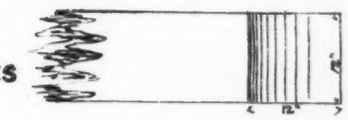

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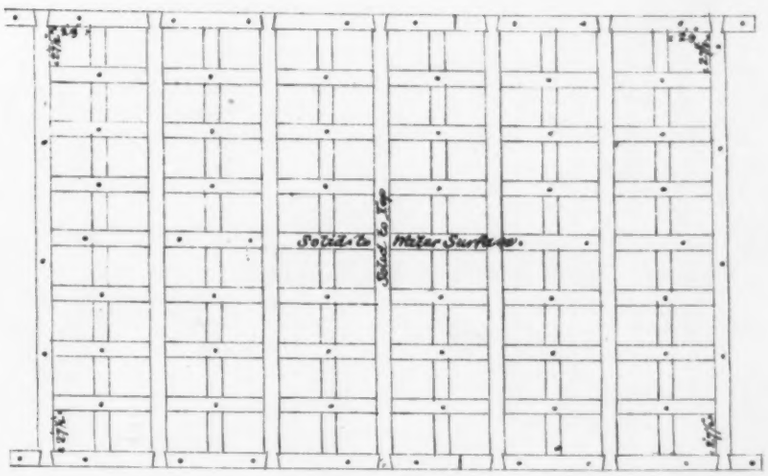
HARBOR



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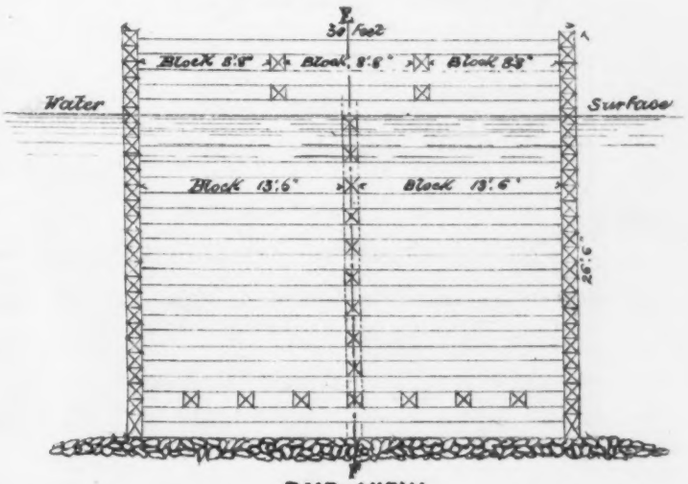

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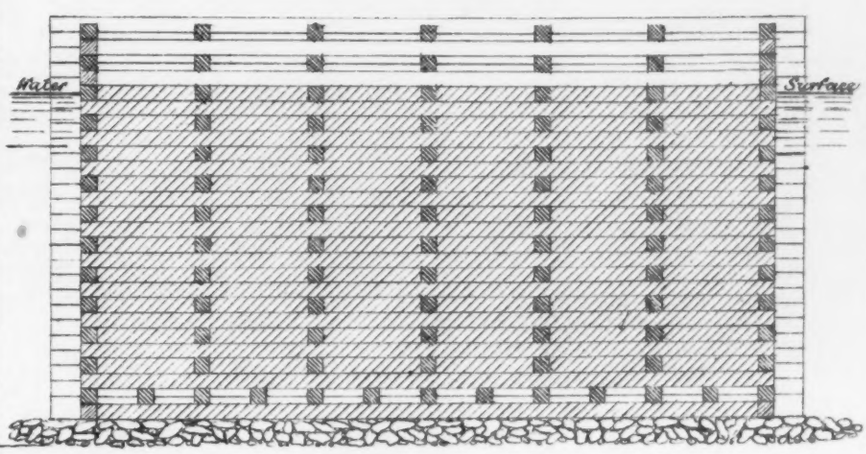

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